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Forest Health Value Analysis and Needs Assessment

John Loomis and Michelle Haefele

Forest Health Value Analysis and Needs Assessment

Final Report for Cooperative Agreement No: 28-CS-892
Between Colorado State University, Department of Agricultural and Resource Economics
and
USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Work Unit MAG

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Dr. Smith:

Enclosed please find a copy of the final report due on December, 31, 1996. This report is submitted in partial fulfillment of the requirements of cooperative agreement number 28-CS-892 entitled "Forest Health Value Analysis and Needs Assessment," between Colorado State University, Department of Agricultural and Resource Economics and the USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Work Unit No. MAG. If you have any questions please contact John Loomis at 491-2485 or Michelle Haefele at 491-6872.

Sincerely,

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Michelle Haefele
Research Associate

December 12, 1996

Final Report for Cooperative Agreement No. 28-C5-892, between Colorado State University, Department of Agricultural and Resource Economics and Rocky Mountain Forest and Range Experiment Station, Research Work Unit No. MAG.

Introduction

This report will describe the project work that has been completed in fulfilment of the Cooperative Agreement. A survey instrument to be used to determine the information needs of Forest Health Staff and National Forest System decision makers has been developed. In addition to determining unmet information needs, this instrument will assess these Forest Service staffs preferences for information formats, information sources currently used, and the extent to which commodity and non-commodity economic values influence forest health decisions.

This survey was developed with the assistance of several Forest Service personnel. Initial versions of the survey were reviewed by Eric Smith of MAG; Randy Rosenberger (a contractor with MAG); Robert Averill, Group Leader for Forest Health Protection in Region 2 and Michael Retzlaff, Region 2 Regional Economist. Revised versions of the survey were then reviewed by Dave Johnson and Bill Schaupp of the Forest Health Protection Lakewood, Colorado Service Center. Comments and suggestions from these focus groups were incorporated into the survey, which was revised, and a pretest was conducted.

A pretest was conducted with district rangers from three districts, along with Forest Health Protection staff from the Gunnison, Colorado Service Center. This group included: Pamela Bode, former Taylor River District Ranger; James Dawson, Cebolla District Ranger; and Jim Free, Ouray District Ranger (all on the Grand Mesa, Uncompahgre, and Gunnison

National Forests); as well as Roy Mask of the Gunnison Service Center.

To further assess the usefulness of the survey instrument an intensive focus group was conducted with members of the public (non resource management professionals). This group was composed of residents of Fort Collins, Colorado, selected at random. This session involved going through each section of the survey instrument and discussing at length any difficulty with wording or any potentially confusing, misleading or leading statements or questions. The current final version of the survey reflects the extensive comments collected in the pretest, the comments and suggestions of the focus group participants, as well as all previous reviewers' comments. The experimental design and survey instrument are in Appendix A and B respectively.

Description of the Survey Methodology

This section will describe the conjoint analysis technique used in the survey, and will give a brief review of some of the other work in natural resoruce economics which has applied this technique. Forest health is one of the most important resource issues facing land management agencies today. Disagreement exists as to the exact definition of forest health, but it can generally be said to include protection from insect and disease outbreaks, as well as the re-establishment of natural regulation systems, such as periodic fire. Healthy forests have characteristics of public goods. For example, they provide habitat for endangered species, protect water quality, provide recreation settings, and deliver a host of non-use values. These benefits are non-exclusive, once they are provided for one, they are available for all. No formal market exists for trading these amenities, and their use by one does not diminish the amount available for another. Estimating these non-market values is an important

component of multiple use land management. The survey developed for this cooperative agreement will use conjoint analysis as a tool for estimating the non-market values associated with public goods.

Non-market or public goods may not have a market price, but they do have a value to society. This value can be estimated using several techniques. These can be divided into two broad groups: 1) those which rely on actual behavior, and 2) those which rely on intended behavior. Actual behavior will give an approximation of the value of some attribute based on the prices paid in actual transactions. This group of techniques includes the hedonic price method and the travel cost method.

The second group of techniques uses survey methods to elicit intended behavior from a sample of the population of interest. These techniques rely on the amount a respondent declares he or she would be willing to pay for some non-market or public amenity. In most experimental settings it is difficult, if not impossible to test the validity of these declarations. Contingent valuation and conjoint analysis are two techniques in the intended behavior group.

Contingent valuation simply asks respondents to estimate their willingness to pay for some public good. This method involves several choices of formats to elicit these responses. One of these formats asks the respondent to provide a discrete answer to a "yes or no" question, asking whether they would pay an offered price to have the amenity or refuse to pay and not receive the amenity. This format most closely resembles the conjoint analysis format.

Conjoint analysis has been used most often in marketing research, and is only recently being applied to natural resources valuation. This technique uses a survey method where a

respondent is presented with a set of choices among a group of products or options. These options are differentiated by a bundle of attributes which represent trade-offs between the choices. One of these attributes will be a price for each option. The respondent is asked to express his or her preferences for these options, usually by rating or ranking them.

Marketing researchers have discovered that when consumers make complex decisions (such as purchase decisions for certain items) they define a set of criteria or attributes which they feel are most important in making the decision about which item to choose or whether to make the purchase at all. These have been called determinant attributes (Louviere, 1988). These determinant attributes will in turn define the final "choice set" from which the consumer will select the most preferred option. The choice set and determinant attributes are defined by the researcher in an experimental setting.

In general, the researcher seeks to determine the probability that a respondent will choose one member of the choice set, and to examine the role of the determinant attributes in that choice. Consumers often make subjective judgements about the value of the level of certain attributes based on their beliefs. These are called psycophysical judgements (Louviere, 1988). Louviere defines a model of complex decision making in which the utility a consumer receives from a certain brand or choice can be derived from a series of relationships between the physical levels of attributes associated with the choice, the consumers beliefs about these levels (and their psycophysical judgements), and the consumer's expected "part worth" utility from each level of the attribute associated with the choice. The part worth utility is the amount that the level of a particular attribute will contribute to the overall utility of the choice. This survey will apply the conjoint analysis

method as a tool to estimate the value of non-market goods.

Traditional non-market valuation has been conducted for many decades using several techniques. These include methods which rely on a consumer's actual behavior, such as travel cost analysis and hedonic price analysis, and methods which ask respondents to reveal behavior they expect or intend to perform. Experimental conjoint analysis most closely resembles this "intended behavior" or contingent valuation method. Within the contingent valuation method, there exist several formats. Much debate has been carried on in the literature as to which of these formats best achieves the researchers objective of inducing the respondent to reveal his or her true willingness to pay (or willingness to accept compensation) for a non-market good.

It has been hypothesized that the more closely a researcher can come to emulating "real world" scenarios the more easily a respondent can reply to a contingent valuation question. That is, consumers are most familiar with paying a pre-determined price for private goods, so a question which asks a respondent to "name your price" (such as open ended and, to some extent, payment card CVM formats) may be so unfamiliar that respondents are unable to give meaningful answers. A format which offers a respondent a "take it or leave it" choice, where the public good is offered for some set price is more familiar, and may be easier for the respondent to grasp and answer.

Taking this emulation of the real world even further, a consumer who is considering making a purchase will usually have several "brands" of a good to choose from. These different brands will have different attributes and/or levels of attributes. Among these attributes is the price of the good. A consumer will weigh each brand and its set of attributes

to determine which most fully meets his or her needs and budget constraint. If a public good is being offered to a consumer for "purchase" he or she may feel most comfortable if the choice involves trade-offs among different levels of attributes and prices. For example, a 200 acre park may cost each household ten dollars per year, a 100 acre park six dollars per year, and a 50 acre park only four dollars per year. A survey respondent will be able to determine what level of this good (the park) they want or will use, and how much they can afford to pay for such an amenity and will make some appropriate selection from among the options.

Mackenzie (1992) uses conjoint analysis to estimate the value of various attributes associated with waterfowl hunting trips. The rate at which travel time is valued has been a subject of debate in travel cost analysis and this paper seeks to address this valuation (in addition to the value of other trip attributes) with the conjoint experiment.

Attribute values can be estimated by asking an individual to compare two bundles, each with a set of attributes. Two attributes in each bundle could (holding all other attributes constant) be varied in opposing directions to reach a point where the two bundles will be equivalent (that is, the individual will be indifferent between them). If a person is indifferent between two choices, the utility derived from each is assumed to be equivalent. The marginal rate of substitution between attributes can be derived from the ratio of the marginal utilities of each bundle. Using the price of each bundle, an indirect utility function can be derived. Again varying price and another attribute to achieve equality between the two bundles, the marginal rate of substitution can be used to represent the marginal willingness to pay for the attribute. In this manner, a value can be estimated for travel time by varying the time and cost of the trip.

Examples of Past Natural Resouce Conjoint Studies

In his paper, Mackenzie examines six attributes of a set of hypothetical waterfowl hunting trips. These attributes are: travel time, total trip cost (per day), the type of group, site congestion, the state hunting license fee and the level of hunting success (number of ducks and/or geese bagged). Each of these attributes was assigned four possible levels. Using software designed for the task, a parsimonious orthogonol design was developed, in which there are 32 possible combinations of attribute levels. These were grouped into eight sets of four, and each respondent was asked to rate only four trips (rather than the full set of 32). These combinations are described to the respondent as possible hunting trips.

The dependent variable in this experiment is the rating assigned to each trip. This variable is not continuous, therefore a qualitative dependent variable regression technique is needed to estimate a model, in this case, the logit functional form was estimated. Using a ratio of the coefficient on each non-cost attribute over the coefficient on the cost per day a marginal cost or willingness to pay can be estimated. A negative ratio represents the cost to the respondent of an attribute which will reduce utility (i.e. congestion), a positive ratio represents the willingness to pay for a benefit (such as increased number of ducks bagged). Each of the attributes were found to contribute to the trip rating as expected.

The author concludes that the conjoint analysis technique can be a useful tool for estimating the value of individual attributes of a public good. This can be important when researchers attempt to value such things as whole ecosystems or land management options which have multiple attributes.

Using the same data set as above, Mackenzie (1993) examines four different models

constructed from the ratings given for each of the trips. The first model used the ratings as indicated by the respondents. The ratings were then transformed into implied rankings. The third model used pairwise comparisons constructed from the ratings of the trips. This model was constructed two ways, one which accounted for "ties" between trips, and one which did not. Binary preferences were constructed for the final model.

Coefficients on the attributes in all of the models had the expected signs, and most were found to be significant. The model using the ratings for the alternative trips had the best performance of the four. The author concludes that this result indicates that the rating scale approach can account for preference intensities, which would not be accounted for in a discrete choice CVM or with the other models examined here. This type of model format can also account for respondent indifference or ambivalence. It has been hypothesized that this ambivalence or indifference manifests itself in the form of non-response to more traditional non-market valuation surveys, leading to bias in these studies.

Roe et al. (1996) derive estimates of compensating variation associated with salmon fishing trips using conjoint analysis. This experiment has respondents rate an option which represents the status quo, or current resource condition, in addition to alternative conditions. Various functional forms and constructions of the dependent variable (similar to Mackenzie's 1993 paper) are examined and compared in order to explore which will best achieve an estimate of compensating variation.

Respondent preferences are analyzed three ways: 1) conjoint ratings are treated as cardinal preferences and analyzed using tobit models; 2) assuming transitivity of preferences, ratings are converted to implied rankings and ordinal preferences are analyzed using ordered

logit models; and 3) binary logit models are estimated where the dependent variable is simply whether the respondent gave an alternative scenario a higher or lower rating than the status quo.

This study employed a mail survey to examine changes in salmon fisheries on the Penobscot River in Maine. The commodity valued was a day of salmon fishing. Attributes of such a trip are varied among the choices to be rated by respondents. These attributes were fishery type (hatchery or natural), size of the salmon run, fishing method allowed (fly only or fly and lure), catch restrictions (the type and-number of fish which can be kept), restoration of salmon on other rivers (either status quo or increased stocking) and a randomly selected daily cost for the fishing trip. Each respondent rated four different scenarios, one of which was the status quo. A ten-point rating scale was used, with ten being the most preferred and one the least preferred.

The researchers use four functional forms to examine the preferences based on the rating of the trips. The first uses a linear model with ratings as the dependent variable and the other attributes, along with respondent characteristics as explanatory variables. The price of the day of fishing is used as an explanatory variable in this model. The second model is similar, but the income and price variables are combined (using income minus price). The third is again a linear model, with the difference between the rating of the status quo and the rating of the alternative scenario used as the dependent variable. Independent variables are also constructed form the differences between alternative and status quo attribute levels. The fourth model uses ratings differences as the dependent variable and a non-linear functional form for price and for the size of the salmon run.

In addition, a ranking was constructed from each respondent's ratings of the trips. This ranking is based on an assumption of transitivity of preferences, with the highest rated trip being ranked first, the lowest rated trip ranked last. Three ordered logit models were then estimated using these constructed ratings. As a final examination of the data, Roe, et al. construct a binary dependent variable. This variable is equal to one if a trip received a higher rating than the status quo, and zero otherwise. Two binary logit models were estimated using this dependent variable.

These models were then compared on the basis of significance of coefficients and consistency with economic theory. The ratings difference models and the binary models have significant coefficients on price and/or income variables, with signs that agree with theoretical expectations. The ratings and rankings models have insignificant coefficients that in some cases disagree with expectations. It was found that the tobit ratings difference models had the most significant coefficients on management attributes, and the binary logit models had the fewest.

Finally, the researchers calculated and compared estimates of compensating variation for each of the models. The linear and non-linear ratings difference models are compared to look at how functional form affects welfare measures. It was found that the non-linear model produced compensating variation measures which were more than twice as large as those derived from the linear model, but with wider confidence intervals. A comparison between the linear ratings difference model, the ad hoc rankings model and the linear binary model was performed to examine how the methodology affects the welfare estimate. These models all produce the same first choice (based on welfare measure) of management programs, but

differ on the ordering of the other programs examined.

The authors conclude that from a theoretical perspective, models based on ordinal rankings of preference are most consistent, and that statistical tests indicate that the logit ranking model performs better than the tobit ratings difference model. However a ratings difference model removes noise due to differences between individual respondents anchoring of ratings within the rating scale. Also, the functional form used has implications for policy analysis, as a non-linear form produces estimates of welfare change which are much greater than those derived from linear models. A comparison between rankings, ratings difference and binary models indicates a violation of the assumption of transitive preferences, but the authors speculate that this may be an artifact of the response format.

Revealed preference and stated preference methods are combined by Adamowicz, et al. (1994). Data was collected by randomly contacting households within the study region. These respondents were asked about their past participation in water based recreation. Those who had engaged in such recreation were asked about their trips to develop the revealed preference data, and solicited to complete a mail survey which contained the stated preference portion of the study.

Three choices were presented to the respondents in the mail survey. These are a recreation trip to a standing water site, a trip to a running water site, or staying at home. The attributes of each of the trips are designed to reflect the actual attributes of different sites within the study region and include distance to the site, water quality, facilities at the site, whether swimming is available and numbers of fish caught, as well as a day use access fee. The revealed preference model used information on the actual trips taken by the respondents,

and the attributes of these trips were the actual levels of the same set of attributes used in the stated preference model.

The stated preference data were analyzed using a random utility model. All attributes had signs which were consistent with the researchers' expectations. Utilities for each attribute were constructed based on each respondents choice from among the three alternatives offered. The revealed preference data were analyzed using a multinomial logit model of travel cost. The goodness of fit of the revealed preference model was found to be lower than that of the stated preference model. Welfare measures were calculated for each model, and the measures for the stated preference model were higher than those for the revealed preference model.

In addition to the separate models, a joint stated and revealed preference model was also estimated. Combining the data and estimating a joint model reduced colinearity which was found in the revealed preference model and allowed the researchers to expand the range of attribute levels to include proposed or expected changes which do not currently exist. Chi squared tests performed on the two data sets indicate that the preference structure is the same for revealed and stated data.

The authors conclude that the stated preference method used in this study, conjoint analysis, should be of use to those wishing to estimate values for non-market goods. Their comparison between stated preference and revealed preference data indicate that the underlying structure is similar. This has implications for valuing non-market amenities which involve complex trade-offs between attributes.

Implications for this Forest Health Survey

Forest health is a non-market good which is composed of multiple attributes. Management to maximize one or more of these attributes may lead to losses or changes in the levels of other attributes. Public preferences for the various amenities and services of healthy forests can be expected to be quite diverse. Given this set of circumstances, conjoint analysis may be an appropriate tool to estimate the values of various attributes of management activities to protect or restore forest health.

One aspect of forest management is the prevention or eradication of insect and disease infestations. Pest management involves a wide variety of activities each with different levels of success and different extraneous consequences. It can be expected that different members of society may place different weights on the various attributes of a pest management system. Also, the nature of the infestation can be expected to influence the valuation of pest management activities. For example, the value of a control program directed at an introduced pest may be different than that of a native species. Forest insects or diseases affect a variety of resources in different ways. For example an infestation of insects may reduce timber values, while at the same time increasing insect-eating bird populations and habitat for some wildlife. Pest management actions will obviously have different effects on these resources, and different levels of management will have different levels of impacts and different costs. Different members of society may have very different values for the services they expect from land management agencies, and conjoint analysis can be a tool to estimate what these are.

Conjoint analysis can be used to estimate values for the various attributes affected by

a pest management program. Several alternative programs can be presented to survey respondents, each with different levels of attributes such as timber, recreation, wildlife and water quality. Each option will have a specified cost and a status quo (or no control) option can also be presented. If respondents rate these options, implicit values for the various attributes can be derived using the techniques described above.

Although conjoint analysis has been used widely in market research, relatively little work has been done using conjoint analysis to value non-market goods. Most non-market research using conjoint analysis has been in the valuation of recreation amenities. Use of this technique to value multi-attribute land management choices will be beneficial in two ways. First, examining the separate attributes of land management actions may offer greater insight into the values held by people for public lands, and help determine the appropriate set of management alternatives to be implemented. And second, further examination of the conjoint analysis technique to estimate the values of more diverse non-market goods will help to refine this addition to the environmental economics toolbox.

Effective management of public lands and resources, including forest resources, requires a full accounting of the values of these resources. Expanding the methodologies available to measure non-market values can only increase the completeness of the information available to land managers and political decision makers.

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Appendix A

Experimental Design

Treatment Levels

Experimental Design												
Generic:												
	Version 1		Version 2		Version 3		Version 4		Version 5		Version 6	
Attribute:	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3
acres	L	L	L	H	L	L	H	H	H	L	H	H
cost	L	L	H	L	L	H	H	H	L	H	H	L
insects	H	L	L	L	L	H	H	L	H	H	L	H
birds	H	H	L	L	L	H	L	H	H	L	H	L
streamflow	H	H	L	H	L	L	H	L	L	H	H	L
erosion	L	H	H	H	L	H	H	L	H	L	L	L
RVD's	H	L	H	H	L	H	L	L	L	L	H	H
timber	H	H	H	L	L	L	H	H	L	L	L	H
Scenario A - Gypsy Moth:												
	Version 1		Version 2		Version 3		Version 4		Version 5		Version 6	
Attribute:	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3
acres	426	200	426	425	426	200	650	425	650	200	650	425
cost	10	43	42	43	10	75	42	75	10	75	42	43
insects	-18	-19	-5	-19	-5	-40	-18	-19	-18	-40	-5	-40
birds	4	-14	-13	-30	-13	-14	-13	-14	4	-30	4	-30
streamflow	5	2.5	2.6	2.5	2.6	0	5	0	2.6	2.5	5	0
erosion	2.6	2.5	5	2.5	2.6	2.5	5	0	5	0	2.6	0
RVD's	-5	-4	-9	0	-9	0	-9	-4	-9	-4	-5	0
timber	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change

Scenario B - Southern Pine Beetle												
	Version 1		Version 2		Version 3		Version 4		Version 5		Version 6	
Attribute:	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3
acres	8	1	8	7	8	1	14	7	14	1	14	7
cost	10	43	42	43	10	75	42	75	10	75	42	43
insects	-5	-20	-12	-20	-12	-13	-5	-20	-5	-13	-12	-13
birds	-6	0	-10	-5	-10	0	-10	0	-6	-5	-6	-5
streamflow	9	4	5	4	5	0	9	0	5	4	9	0
erosion	5	4	9	4	5	4	9	0	9	0	5	0
RVD's	-8	-7	-8	0	-14	0	-14	-7	-14	-7	-8	0
timber	-18	-5	-18	-17	-39	-17	-18	-5	-39	-17	-39	-5
Scenario C - Western Spruce Budworm												
	Version 1		Version 2		Version 3		Version 4		Version 5		Version 6	
Attribute:	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3	Opt 2	Opt 3
acres	9	2	9	8	9	2	8	14	14	2	14	8
cost	10	43	42	43	10	75	42	75	10	75	42	43
insects	-1	-30	-14	-30	-14	-15	-1	-30	-1	-15	-14	-15
birds	0	-5	-4	-10	-4	-5	-4	-5	0	-10	0	-10
streamflow	4	2	2.1	2	2.1	0	4	0	2.1	2	4	0
erosion	2.1	2	4	2	2.1	2	4	0	4	0	2.1	0
RVD's	-7	-6	-7	0	-14	0	-14	-6	-14	-6	-7	0
timber	-8	-5	-8	-7	-19	-7	-8	-5	-19	-7	-19	-5

Appendix B

Survey Instrument

11/19/96

Managing Forest Health

What Do You Think?

Department of Agricultural and Resource Economics
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Forest Health Challenges Faced by Land Management Agencies Today

Our forests have undergone significant change during our nation's history. Timber harvests, fire suppression, accidental introduction of non-native forests pests, and air pollution have altered the forest resource and the natural forces which shape it.

What Are the Options for Managing Forest Health?

There are a variety of tools forest managers might use to maintain or re-establish a healthy, forest ecosystem in the public forests in the United States. In the table below, please tell us which tools you feel are appropriate for forest managers to consider using in the forest where you live, work or recreate.

	Always Appropriate to Consider	Frequently Appropriate to Consider	Occasionally Appropriate to Consider	Never Appropriate to Consider	Don't Know
1. trapping undesirable insects to reduce their population	☐	☐	☐	☐	☐
2. cutting of individual dead or dying trees	☐	☐	☐	☐	☐
3. paying to thin out forest stands	☐	☐	☐	☐	☐
4. selective harvest of live trees	☐	☐	☐	☐	☐
5. harvest of groups of live and dead trees	☐	☐	☐	☐	☐
6. clear cutting	☐	☐	☐	☐	☐
7. controlled burn for vegetation control or management	☐	☐	☐	☐	☐
8. controlled burn for pest control	☐	☐	☐	☐	☐
9. apply chemical pesticides by hand	☐	☐	☐	☐	☐
10. aerially apply chemical pesticides	☐	☐	☐	☐	☐
11. apply biological or natural insecticides	☐	☐	☐	☐	☐
12. enhance production of natural enemies of native forest pests	☐	☐	☐	☐	☐
13. introduce natural enemies of non-native pests	☐	☐	☐	☐	☐
14. reforestation using pest resistant trees	☐	☐	☐	☐	☐
15. other (please list):					
________________	☐	☐	☐	☐	☐
________________	☐	☐	☐	☐	☐

In your area, what do you consider to be the major threat to forest health?

____

In your area, what do you consider to be the three most important forest insect and/or disease problems?

1. ____

2. ____

3. ____

Forest protection can be expected to have certain benefits and byproducts. For the area where you work, please evaluate the importance of the following benefits of forest health protection.

	Very Important	Somewhat Important	Rarely Important
1. timber production	☐	☐	☐
2. livestock forage	☐	☐	☐
3. water **quantity**	☐	☐	☐
4. water **quality**	☐	☐	☐
5. fire danger reduction	☐	☐	☐
6. developed recreation	☐	☐	☐
7. dispersed recreation	☐	☐	☐
8. consumptive use of wildlife	☐	☐	☐
9. non-consumptive use of wildlife	☐	☐	☐
10. threatened or endangered plants and animals	☐	☐	☐
11. visual quality	☐	☐	☐
12. special uses of Forest Service lands	☐	☐	☐
13. other (please list):			
______________________	☐	☐	☐
______________________	☐	☐	☐
______________________	☐	☐	☐

What documents or written information do you use in making forest health management decisions or recommendations?

	Don't Use	Use Occasionally	Use Frequently
1. Forest Insect and Disease Leaflets	☐	☐	☐
2. FS Standards and Guidelines	☐	☐	☐
3. Integrated Pest Management Guides	☐	☐	☐
4. Research Station Publications (GTR's, RN's, etc.)	☐	☐	☐
5. Management Bulletins	☐	☐	☐
6. Forest Service Handbooks/Manuals	☐	☐	☐
7. Other publications from the Forest Service	☐	☐	☐
8. Guidance from Washington Office	☐	☐	☐
9. Professional or scientific journals	☐	☐	☐
10. other (please list):			
______________________	☐	☐	☐
______________________	☐	☐	☐
______________________	☐	☐	☐

In the forest health management decisions you participate in, who (or what) do you rely upon for input?

	Very Rarely Rely Upon	Sometimes Rely Upon	Often Rely Upon	Not Applicable
1. My own technical or professional training	☐	☐	☐	☐
2. My own professional experience	☐	☐	☐	☐
3. Personal knowledge of the location	☐	☐	☐	☐
4. Recommendations of Forest Service Forest Health staff specialist	☐	☐	☐	☐
5. Recommendations of Staff Officers	☐	☐	☐	☐
6. Preferences of local residents	☐	☐	☐	☐
7. Preferences of forest products industry	☐	☐	☐	☐
8. Preferences of recreation user groups	☐	☐	☐	☐
9. Preferences of environmental and wildlife groups	☐	☐	☐	☐
10. US Environmental Protection Agency	☐	☐	☐	☐
11. US Fish and Wildlife Service	☐	☐	☐	☐
12. Other Federal agencies	☐	☐	☐	☐
13. State wildlife agency	☐	☐	☐	☐
14. State forestry agency	☐	☐	☐	☐
15. Other state natural resource agencies	☐	☐	☐	☐
16. City and county agencies	☐	☐	☐	☐
17. Computer models (please specify):				
______________________________	☐	☐	☐	☐
______________________________	☐	☐	☐	☐
______________________________	☐	☐	☐	☐
______________________________	☐	☐	☐	☐
18. other (please list):				
______________________________	☐	☐	☐	☐
______________________________	☐	☐	☐	☐
______________________________	☐	☐	☐	☐
______________________________	☐	☐	☐	☐

Trade-offs in Forest Health Management -
Which Ones Would You Make?

Managers have several options to protect forest health. Control of insect or disease outbreaks can include such actions as cutting smaller trees which have no commercial value to thin forest stands or harvest and sale of selected trees in areas with a high risk of outbreak. Monitoring and trapping of insects can help identify potential problems. An outbreak may occur if control or early detection is not done or if such prevention fails. Control actions may be taken, which may or may not stop an outbreak, but could mitigate the impacts of an outbreak.

When insect or disease outbreaks occur and are in the process of killing trees, there are also several options:

- Do nothing and let nature take its course
- Take various control actions, including:
  - removal of infested trees
  - removal of dead trees
  - thinning to give remaining trees a better chance to survive
  - controlled burning
  - spraying of pesticides.

All of these choices involve trade-offs. The forests will look different, support different types of wildlife and support different recreational activities, now and in the future. Of course these different actions also have different costs to us as taxpayers and have different risks to the environment.

On the next three pages we ask you to choose the options you would prefer to deal with pest problems. Please read each description carefully and take your time in answering. These scenarios are designed to force you to make trade-offs between various attributes of a pest management program, and may not be realistic in every possible detail. Please make choices based on your preferences for the various levels of attributes presented for each option, rather than your expectations about these levels.

Scenario A

Insect: Gypsy Moth - introduced to the United States from Europe in the 1800's
Tree Species/Forests Affected: hardwoods, especially oaks, and sometimes conifers
Area Impacted: Northeastern United States
Size of Currently Impacted Area: approximately 156 million acres in the generally infested area
Impacts of Uncontrolled Infestation:

Wildlife impacts:	Dead trees can provide nest sites for some birds and small animals Insect-eating birds increase
Water resource impacts:	Water yield and temperature may increase Oxygen levels in streams may decrease
Forest ecosystem impacts:	Reduced tree growth in moderate outbreaks, trees may die if defoliation occurs year after year Other insects or diseases may infect weakened trees Shrubs increase as overstory trees die during heavy outbreaks Large numbers of dead trees increase fire danger
Homeowner impacts:	Creates a nuisance around homes and businesses Loss of shade around homes increases cost of cooling
Recreation impacts:	Loss of shade, unsightly dead trees, and danger from falling dead trees
Economic impacts:	Commercial timber losses are small Quarantines in infested areas have economic impacts on businesses by reducing the area they can sell to

Options for Pest Management:

Option 1: **No Action**

Option 2: **Moderate level of forest pest management** - reduce the adverse effects of the gypsy moth only in the generally infested area by using insecticides (both natural and chemical).

Option 3: **High intensity forest pest management** - Eradication of isolated infestations in areas outside the generally infested area, suppression of populations within the generally infested area, and slowing the spread of gypsy moth infestations. This option will use the same insecticide treatments as Option 2, along with non-insecticide treatments (mass trapping, disruption of mating with artificial pheromones, and mass release of sterile insects).

Effects of the Options:	**Option1:**	**Option 2:**	**Option 3:**
Acres infested by gypsy moth in 15 years	700 million	500-650 mill	200-350 mill
One-time cost of the **control option** to all taxpayers, including you	0	$75	$100
Changes in forest resources:			
• non-target **insect** populations	no change	-5 to -17%	-29 to -40%
• insect-eating bird populations	+5%	+4 to -7%	-18 to -30%
• water resources:			
change in streamflow	+5%	+3.5 to +5%	0 to +1.7%
change in erosion	+5%	+3.5 to +5%	0 to +1.7%
possible contamination from spraying	no	yes	yes
• recreation visitor days	-10%	-9 to -6%	-3 to 0%
• commercial timber	no change	no change	no change

Using the information about the options and their effects given above, please **rate** all three possible management actions. Use a scale of one (1) to ten (10), where one is the lowest rating and ten is the highest rating.

Option1:	**Option 2:**	**Option 3:**
☐	☐	☐

Scenario B

Insect: Southern Pine Beetle - native to the Southern United States
Tree Species/Forests Affected: pines, especially loblolly and shortleaf
ea Impacted: Southeastern United States
..e of Impacted Area: approximately 10 million acres
Impacts of Uncontrolled Infestation:

Wildlife impacts:	Some wildlife species benefit from Southern Pine Beetle infestations: • some woodpeckers are predators of Southern Pine Beetle • provides standing dead trees for nesting • increases habitat for quail, rabbit, deer, and small mammals which require forest openings Causes a loss of habitat for the endangered red-cockaded woodpecker
Water resource impacts:	Water yield increases from loss of vegetation cover Soil erosion and water temperature also increase
Forest ecosystem impacts:	Increases the severity of wildfires due to increased fuel
Recreation impacts:	Loss of shade, unsightly dead trees, and danger from falling dead trees
Economic impacts:	Large commercial timber losses during epidemic periods

Options for Pest Management:

Option 1: **No Action**

Option 2: **Moderate level of forest pest management** - Use Integrated Pest Management (IPM) in general forest area. In addition, direct control actions will be taken as needed in outbreak situations. No actions will be taken in wilderness areas.

1. Integrated Pest Management:
   a. reduce acreage in mature trees
   b. thinning of dense pine stands
   c. replanting cleared forests with more resistant tree species
   d. planting a more diverse mixture of tree species
2. Direct Control Actions:
   a. cutting and removing infested trees
   b. cutting and leaving infested trees
   c. cutting and hand spraying infested trees
   d. cutting and burning infested trees

Option 3: **High intensity forest pest management - Adds** action in Wilderness Areas to protect red-cockaded woodpecker habitat and adjacent State, private, and high value Federal lands. This option will use the direct control actions described above (for Option 2), except action 2.d. above (cutting and burning of trees) in wilderness. This option will also use Integrated Pest Management (as described above) in the general forest area.

Effects of the Options:	**Option 1:**	**Option 2:**	**Option 3:**
Acres infested by southern pine beetle in 15 years	15 million	9-14 million	1-5 million
One-time cost of **control option** to all taxpayers, including you	0	$75	$100
Changes in forest resources:			
• non-target **insects** populations	no effect	-5 to -10%	-15 to -20%
• insect-eating bird populations	no effect	-6 to -10%	0 to -4%
• water resources			
change in streamflow	+10%	+6 to +9%	0 to +3%
change in erosion	+10%	+6 to +9%	0 to +3%
possible contamination from spraying	no	no	no
• recreation visitor days	-15%	-10 to -14%	0 to -3%
• commercial timber	-40%	-39 to -27%	-5 to -16%

Using the information about the options and their effects given above, please **rate** all three possible management actions. Use a scale of one (1) to ten (10), where one is the lowest rating and ten is the highest rating.

Option 1:	**Option 2:**	**Option 3:**
☐	☐	☐

Scenario C

Insect: Western Spruce Budworm - native to most fir stands
Tree Species/Forests Affected: Douglas-fir, grand fir, white fir, Engelmann spruce, subalpine fir, western larch
Area Impacted: Eastern Cascade mountains of Oregon and Washington, Northern and Central Rocky Mountains
Size of Impacted Area: approximately 7 million acres
Impacts of Infestation:

Wildlife impacts:	Severe repeated infestation will reduce habitat for some songbirds
Water resource impacts:	Slight increase in runoff, leading to soil erosion and siltation of streams
Forest ecosystem impacts:	Visual quality is reduced due to areas of dead or damaged trees Increased fuel loads in forests increase the severity and likelihood of wildfires Reduced regeneration and timber production due to growth loss, deformity, reduced seed production and tree mortality
Recreation impacts:	Loss of shade, danger from falling dead trees
Economic impacts:	Commerical timber losses during sever infestations

Options for Pest Management:
Option 1: **No Action**

Option 2: **Moderate level of forest pest management** - Aerial application a natural insecticide (such as B.t.).

Option 3: **High intensity forest pest management** - Aerial application of a chemical insecticide (such as carbaryl).

Effects of the Options:	**Option 1:**	**Option 2:**	**Option 3:**
Acres infested by western spruce budworm in 15 years	15 million	10-14 million	2-6 million
One-time cost of the **control option** to all taxpayers, including you	0	$75	$100
Changes in forest resources:			
• non-target **insect** populations	no effect	-1 to -11%	-20 to -30%
• insect-eating bird populations	+5%	0 to -3%	-6 to -10%
• water resources			
change in streamflow	+5%	+2.6 to +4%	0 to +1.3%
change in erosion	+5%	+2.6 to +4%	0 to +1.3%
possible contamination from spraying	no	no	yes
• recreation visitor days	-15%	-10 to -14%	0 to -5%
• commercial timber	-20%	-15 to -19%	-5 to -10%

Using the information about the options and their effects given above, please **rate** all three possible management actions. Use a scale of one (1) to ten (10), where one is the lowest rating and ten is the highest rating.

Option 1:	**Option 2:**	**Option 3:**
☐	☐	☐

Types of information you would like to have when making forest health management recommendations and decisions:

eed information on:

	Strongly Agree	Agree	Disagree	Strongly Disagree
Impacts of Pest Outbreaks and/or Treatments				
• Landscape scale impacts of pest outbreaks	☐	☐	☐	☐
• Impacts of pest **outbreaks** on biodiversity	☐	☐	☐	☐
• Impacts of pest **treatments** on biodiversity	☐	☐	☐	☐
Effects of Prevention and Control				
• Identification of resources that may benefit from pest management	☐	☐	☐	☐
• Identification of resources that may be adversely affected by pest management	☐	☐	☐	☐
• Quantification of physical effects of pest infestation	☐	☐	☐	☐
• Quantification of physical effects of pest control	☐	☐	☐	☐
• Estimating economic benefits of forest health management for resources:				
timber	☐	☐	☐	☐
recreation	☐	☐	☐	☐
fish and wildlife	☐	☐	☐	☐
water quality and quantity	☐	☐	☐	☐
others:				
____________________	☐	☐	☐	☐
____________________	☐	☐	☐	☐
Costs of Prevention and Control				
• Costs per acre of different technical treatments (spraying, cutting, etc.)	☐	☐	☐	☐
Public Preferences for Forest Health Management Actions				
• Preferences of nearby residents	☐	☐	☐	☐
• Preferences of visitors	☐	☐	☐	☐
• Preferences of environmental groups	☐	☐	☐	☐
• Preferences of commodity industries	☐	☐	☐	☐

I need information on:

	Strongly Agree	Agree	Disagree	Strongly Disagree
Available Technical Solutions				
• Types of alternative treatments available	☐	☐	☐	☐
• Use of biological controls for pest management	☐	☐	☐	☐
• Effectiveness of alternative treatments	☐	☐	☐	☐
• Techniques for identifying outbreaks	☐	☐	☐	☐
• Techniques for monitoring outbreaks	☐	☐	☐	☐
• Computer models (please specify)				
______________________	☐	☐	☐	☐
______________________	☐	☐	☐	☐
Other Information				
• Impacts of fire suppression on the intensity and duration of pest outbreaks	☐	☐	☐	☐
• Knowledge of "pre-settlement" ecological conditions	☐	☐	☐	☐
• Techniques for detecting exotic pests	☐	☐	☐	☐
• Inventory methods for biodiversity measurement	☐	☐	☐	☐
• Techniques for reintroducing fire into the ecosystem under controlled conditions	☐	☐	☐	☐
Other (please list)				
______________________	☐	☐	☐	☐
______________________	☐	☐	☐	☐
______________________	☐	☐	☐	☐

Forest health means different things to different people. How would you describe forest health? (Please use the space below.)

____

____

____

____

____

____

Your responses are completely confidential and will only be used for the analysis of this study. You will not be identified in any way.

How often do you visit National Forests for recreation? _________ trips in the last 12 months

2. Check the activities which you participate in frequently:

☐ hiking	☐ wildlife viewing	☐ other (please list)
☐ camping	☐ mountain biking	________
☐ hunting	☐ backpacking	________
☐ fishing	☐ skiing	

3. What is your zip code? ____________________

4. Are you male ☐ or female ☐

5. What is your age: _________ years

6. What is your highest level of formal schooling (please circle one number):

1 2 3 4 5 6 (Elementary)	7 8 9 (Jr. High)	10 11 12 (High School)	13 14 15 16 (College)	17 18 19+ (Graduate/Professional School)

7. If you have a college degree or are in college, what was/is your major for your highest degree?

____________________ major

Occupation: ______________________________

number of years in your current position: ________________

9. Would you say you **grew up** in (please check one):

☐ a city or urban area ☐ a small town or rural area
☐ a suburban area ☐ a farm or ranch

10. Would you say you **currently live** in (please check one):

☐ a city or urban area ☐ a small town or rural area
☐ a suburban area ☐ a farm or ranch

11. Are you currently a member of an environmental or conservation organizaiton?

☐ yes ☐ no

11. What was your household's combined income before taxes in 1995? (Please check one)

☐ \$10,000 - \$19,000	☐ \$20,000 - \$29,000	☐ \$30,000 - \$39,000
☐ \$40,000 - \$49,000	☐ \$50,000 - \$59,000	☐ \$60,000 - \$69,000
☐ \$70,000 - \$79,000	☐ \$80,000 - \$99,000	☐ \$100,000 or more

Thank you very much for completing this survey. Please return the survey in the postage paid return envelope.
If you have any additional comments, please write them on the back of the survey.
If you would like to receive a copy of the results of this survey, please fill out the enclosed postcard and mail it to us.

Do you have any comments? Please use the space below to tell us any more information you may feel is important for forest health or forest pest management. Thank you for your help with this important land management issue.

A Review of Existing Resources and Guidance for Forest Pest Management Decision Makers in the USDA Forest Service

Michelle Haefele and John Loomis
Colorado State University

Public land management decision makers in the USDA Forest Service, as well as the other land management agencies, are facing an ever increasing group of constituents with a variety of often conflicting values and preferences. These often vocal groups are actively involved in the planning and decision-making processes of all of the land management agencies charged with the stewardship of our nations public lands. This expanded group of stakeholders affects all aspects of land management, including Forest Pest Management, within the Forest Service.

Not only has the group of interested citizens expanded, but the set of values held by these groups had also expanded to include non-timber values, and non-commodity (or non-market) values. Non-market values present an especially challenging problem for decision-makers in the Forest Service, and this review of relevant literature seeks to determine what guidance currently exists to assist decision-makers in the Forest Service in determining activities to control and prevent pest outbreaks in National Forests.

Current agency guidance includes technical advice, such things as reviews or comparisons of various pesticides or application methods, directions for silvicultural practices, and entomological information on specific pests and forest systems. There is no apparent lack of this type of reference materials, aimed at both public and private land managers. A second set of references deals with the economic aspects of management decisions. This group can be divided further into market or timber value oriented work and work which deals with other forest values. A review of the Forest Service literature indicates that there is a small body of guidance dealing with timber values in various ways, but almost nothing within the agency dealing with non-timber and non-market values.

TECHNICAL GUIDANCE

The first group of guidance materials we will examine will be the technical information on various pests. Materials will be further divided into broad National level guidance and guidance directed toward specific regions or pests. This review will focus on any decision criteria included in these papers.

Forest Health Through Silviculture and Integrated Pest Management: A Strategic Plan. USDA Forest Service, 1988.

> This is a report prepared by a task force led by Kenneth H. Knauer of Forest Pest Management. The task force included members from State and Private Forestry,

Forest Insect and Disease Research, Timber Management, Timber Management Research, Cooperative Forestry, and Forest Environment Research. The stated objective of the task force was to enhance and maintain the health of the Nations's forests by developing a USDA Forest Service strategic plan to be implemented through Forest Service programs and authorities.

The report discusses issues and offers options to address each issue. These include: planning (including Integrated Pest Management in forest plans), public involvement, resource management (some forest resource management practices aggravate pest problems), pest suppression, environmental analysis, pesticides, pest control technology (cites technology transfer problems) and forest health monitoring.

Pest and Pesticide Management on Southern Forests, USDA Forest Service, Southern Region, Atlanta GA, Management Bulletin R8-MB60, September 1994

This paper contains sections on the forest ecosystem, stand ecology and forest types of the south, forest pests, principles of forest pest management, integrated pest management, vegetation control, chemical insect and disease control, orchards and nurseries, safety and environmental concerns. The perspective of this paper is timber oriented: "...trees are considered the crop." No economic criteria are provided, however, a list of steps to solving pest problems is provided, offering decision criteria which would be applicable to any region of the Forest Service. The steps are as follows: 1) correctly identify the pest, 2) know what control methods are available, 3) know, and follow all regulations, 4) evaluate the benefits and risks of each method (it is interesting that costs are not mentioned), 5) choose a method that is effect yet will cause least harm to environment, and 6) correctly apply the treatment

Technology transfer in integrated pest management in the South. 1985. USDA Forest Service, Southeastern Forest Experiment Station, General Technical Report SE-34.

This report describes an aggressive research program to address "...a regional problem involving five bark beetle species and three tree-killing diseases affecting Southern pine forests." This five-year program is called the Expanded Southern Pine Beetle Research and Applications Program (ESPBRAP). The goal was to provide more effective ways of dealing with the problem and to deliver information to the ultimate users. The users of the pest management technology and information are primarily owners and managers of pine timberlands in the South.

The reports details a plan for technology transfer through forestry organizations, primarily the State and Private Forestry Organization of Forest Service's Southern Region. Secondary transfer agents include: National Forests and other Federal agency regional offices, State forestry organizations, the cooperative extension service and major timber companies with pest management specialists.

Techniques for transfer of information include: newsletters, direct user involvement in planning of research and development, preparation of technology transfer plans as part of research and development proposals, involvement of research and development investigators in technology transfer process, written and visual material, training programs, hands-on training in computerized information and decision support and demonstration projects of integrated pest management techniques. The ESPBRAP produced handbooks, newsletters, technical bulletins and fact sheets.

The bulk of this report consists of papers reporting the findings of various researchers. These projects all present technical suppression and silvicultural practices. The authors are from the Forest Service, state forestry commissions, state natural resource departments, state forestry departments and universities.

McCambridge. Duration and Effectiveness of Carbaryl in Protecting Ponderosa Pines from Attack by Mountain Pine Beetles. 1981. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Note RM-408. (pamphlet)

This paper offers the results of a laboratory experiment to determine the effectiveness of two different levels of application for a specific pesticide (carbaryl). The report describes the research methods in detail. A brief paragraph analyzing costs of the two different spraying programs is included, however nothing about other values is mentioned. The information is aimed at managers of "high value forests." I've included this as a representation of the type of technical information available. To include all of the various papers on specific pests and pesticides is beyond the scope of this paper.

Integrated Pest Management Guide: Arizona Five-Spined Ips, *Ips lecontei Swaine,* and Pine Engraver, Ips pini (Say), in Ponderosa Pine, by Douglas L. Parker (pamphlet), USDA Forest Service, Southwestern Region R-3 91-8

Integrated Forest Protection Guide: Southwestern Dwarf Mistletoe, *Arceuthobium vaginatum*, subsp. *cryptopodum* (Engelm.) Hawks and Wiens, in Ponderosa Pine. by Jerome S. Beatty. 1986 USDA Forest Service, Forest Pest Management, Southwestern Region R-3 82-13 (pamphlet)

Integrated Forest Protection Guide: Western Spruce Budworm in the Southwest. by James P. Linnane, USDA Forest Service, Southwester Region R-3 86-7 1986.

These are three examples of a pamphlet series aimed at land managers, apparently in both private and public timberlands. They provide the life history and habits of the pest in question, evidence of infestation, Integrated Pest Management practices, and prevention and suppression techniques. An interesting quote taken from the first of these pamphlets states that "suppression should be considered as a high-risk decision

and implemented only as a last resort." Again, no economic efficiency criteria are included in these integrated pest management guides.

ECONOMIC GUIDANCE

Analysis of the economic efficiency of various Forest Service programs is abundant, including various analyses of the Forest Pest Management Program in general, and specific control programs at a local or regional level. These analyses do not, however, provide decision making guidance for land managers, per se.

Lewis, Joseph W. An economic review of the forest pest management program. 1992. USDA Forest Service, Forest Pest Management, Washington DC.

This report assess the economic efficiency of each region's Forest Pest Management program, and aggregates these assessments to show national economic efficiency.

The first step in the analysis involved identification of program activities. These activities were grouped into the following broad categories: technical assistance, suppression project support, technology development, information transfer, general pest detection, pesticide use coordination, early warning detection (trapping) and risk rating. Detailed definitions of these activities can be found in the appendices to the report.

Next, expenditures were allocated among the activities, and these allocations were used as a basis for developing production functions to describe FPM effects on forest management objectives. These production functions describe the input/output relationships of a particular program activity. The definition of a production function is expanded to describe the events which would take place following an expenditure of funds, and the resulting benefits. They are designed to include physical inputs and outputs as well as discounted revenue and costs, giving what the analysts declare are complete benefit/cost analyses.

Benefit categories for the Forest Pest Management program are listed: increased timber volume at harvest, program share of suppression benefits, increased seed production from seed orchards, avoidance of personal injury and property damage, shift or accelerate harvest to capture green stumpage value, salvage of dead and dying trees, avoidance of pest and fire suppression costs, protection of threatened and endangered species habitat, avoidance of tree removal/replacement cost, avoidance of tree planting costs, increased seedling production from nurseries, and avoidance of pesticide-related costs. This report did not give any detailed description of how non-market values were estimated for analysis in the production functions.

This study found that in the aggregate the FPM program is operating efficiently (based

on a national present net value which is positive). However, some program areas can be improved, in certain regions.The report gives national breakdowns and regional details.

Buhyoff, G.J., T.C. Daniel, W.B. White, D.O. Hunter. 1986. Integrated pest impact assessment system development: impact model inventory and use system. USDA Forest Service, Forest Pest Management, Methods Application Group (Fort Collins)

This paper reports the results of a survey of Forest Service land managers who were seen as potential users of a model, the Integrated Pest Impact Assessment System (IPIAS), which would "...provide forest planners and managers with an efficient and effective means for projecting socioeconomic and biological impacts of pest outbreaks and alternative management actions designed to reduce losses..." The survey results show that a need exists for such a model, and that a useful base of other models on which to base the IPIAS exists.

The researchers conducted a search to identify and assess existing models for examining stand changes and socioeconomic impacts of management activities, for the purpose of determining their potential compatibility for expansion of the IPIAS model. Thirty-one models were found which met the broad compatibility requirements, however none of these models were useful for examining range, recreation or visual quality.

IPIAS is to be designed to link biological (stand growth, yield, pest effects), economic (stumpage, management costs, local economic effects), and social (recreation, scenic beauty, wildlife) models. It is interesting that the social components contain elements which could just as easily be considered economic. The authors point out that IPIAS is not intended as a decision-making system by itself, but rather as a tool to integrate these sets of impact.

A survey was sent to individuals in Forest Service regions 1 and 6 seeking information on model needs and current model use. the researchers found that most respondents used models for timber management, including those working in pest management. Use of these models was deemed to be extensive, and respondents reported that costs of model use and development were outweighed by the benefits. The researchers concluded that an adequate supply of models exist for the timber management aspect of IPIAS, but that new models would have to be developed for the other proposed components of the model.

All Resources Reporting - Accomplishment and Results Measures

All Resources Reporting is a financial and accomplishment reporting system designed to "...clearly display the relationship between expenditures associated with the

management activities of a National Forest, revenues collected..., and actual accomplishments.."

ARR provides an assessment of the annual social and economic benefit of a National Forest and demonstrates accountability to tax-payers. The ARR is designed to encompass quality factors, and the intention is to expand the system to include "non-traditional" values.

An accomplishment measure "defines or describes the work accomplished from a specific management activity, and captures a majority of the costs for a particular program component as defined in ARR." A results measure "defines or describes the goods, services or conditions from the management of one or more programs, which can be either consumptive or non-consumptive and captures the integrated status of all programs."

Criteria for measures include the ability to be easily reportable and verifiable, and focus on outputs from a National Forest. These measures should also have definitions commonly understood by all Forest Service personnel and by the general public. Measures should be useful for evaluation, and for assessing plan implementation. They should relate to the National Forest's goals and objectives.

The accomplishments and results continuum contains the following elements: a strategic plan, inputs and management activities, outputs (accomplishment and performance indicators), outcomes (results) and performance reports. Accomplishments for the Forest Pest Management are measured in terms of acres of host type (forest type susceptible to a specific pest) protected. Results measures for FPM have yet to be developed.

FSH 1901.17 - Economic and Social Analysis Handbook

This handbook discusses how the policies in the Forest Service Manual on Economic and Social Analysis should be used. It is divided into three sections: 1) evaluating economic efficiency, 2) economic impact analysis and 3) social analysis. Each section presents standard procedures for conducting and reporting analysis.

The handbook defines a long-term analysis period as two or more 5-year RPA planning periods, and a short-term analysis period as one or two years or less. The preferred measure for decision analysis is present net value. Non-market value and public goods are defined, but are not address further.

The section of the handbook on social analysis addresses the effects of Forest Service land management decisions on local communities with links to economic impact analysis. The categories of impacts and community descriptors correspond to descriptions of local communities used in forest plans.

Averill, R.D.; Bunter, J.E.; Lister, C.K.; Sonnen, D.H. 1977. Guidelines for estimating the economic benefits of mountain pine beetle control projects. USDA Forest Service, Forest Insect and Disease Management, State and Private Forestry, Rocky Mountain Region, Technical Report R2-11.

This technical report provides regional guidelines for conducting benefit/cost analysis for Environmental Analysis Reports. Averill et al. give the following steps for benefit cost analysis: 1) determine the discounted losses if an outbreak is uncontrolled, 2) determine the discounted losses under a control project, 3) calculate the benefits of the control project (step 1 minus step 2), 4) determine the costs of control (present value) and 5) calculate a benefit/cost ratio (step 3 divided by step 4). Assumptions made when developing this methodology include: 1) the duration of an outbreak is expected to be 10-15 years, 2) a 30% loss of timber (the distribution of loss is not likely to be random), 4) the planning horizon for a control program is based on the biological potential of the beetle and the host trees, 5) the amount of protection is also based on the biological potential of the beetle and the host. Potential values at risk include: visitor use, residential property (has tables for calculations), timber (also shows detailed instructions for calculations), scenic quality (cites the National Forest Landscape Management Handbook (v. 1 and 2) and FSM 2300 for instructions for calculations). Regarding scenic quality and visitor use: "While scenic quality and usage data in the Visual Management assessment is of high value, not satisfactory system of evaluating its economic worth is available."

Values for the costs of control programs include actual suppressions costs, pre-suppression and post control surveys and environmental analysis, preparation and treatment precautions. In addition to direct costs, this paper cites added costs to the fire program if no controls are implemented due to increased frequency and severity of fires.

The report gives instructions for calculating benefits and costs and goes through a step by step example. Again the main focus is on preventing losses in timber value, but the framework is broad enough to incorporate non-market values as they become available.

Bousfield, W.E.; Brickell, J.E.; Cleeves, J.C.; Dezellem, R.L.; Gregg, T.F.; Hoffacker, T.H.; Johnson, R.R.; Lewis, J.W.; Lightner, G.M.; Quinn,T.P.; Wiitala, M.R. 1984. Economics of Douglas-fir Tussock Moth Control. USDA Forest Service, Forest Pest Management, Washington D.C.

This report details a methodology for evaluating the economic impact of the Douglas-fir tussock moth on forest management objectives, and for assessing the economic efficiency of alternative pest management strategies. The researchers used three linked computer models: one to simulate the effects of an outbreak, one to project forest growth and yield (with and without outbreaks) and FORPLAN (a linear programming

package) to determine the economic efficiency of various control alternatives based on costs of control and benefits (in terms of timber values). This technique can be used to help land managers select the most economically efficient forest management practices over the long run, because it can predict the effects of a pest outbreak before it actually occurs.

Rudis, Victor A. Nontimber values of east Texas timberland. 1988. Resource Bulletin SO-139, USDA Forest Service, Southern Forest Experiment Station.

This report is a companion report to a survey of forest resources conducted in the same region. The nontimber values ascribed to east Texas timberlands are: watershed maintenance, soil retention (slope, aspect, soil types, water bodies), range potential (grassland types), wildlife habitat (endangered species, habitat, food) and recreation opportunities. This report states that "Forest management and planning that considers only timber values had hidden costs in terms of other values foregone. Management to retain nontimber values also may reduce the economic efficiency of timber management."

The format is an inventory of physical attributes which provide conditions necessary for above listed nontimber outputs. While this paper does not provide guidance in estimating nontimber values, it does gives a direction a Forest Pest Manager might go to estimate these values. Non-market and non-commodity values are ignored

Arajii, A. A. The Economic Impact of Investments in Integrated Pest Management. University of Idaho, College of Agriculture, Agriculture Experiment Station, Research Bulletin 115, January 1981

This bulletin deals with agricultural pest management. The objectives of the research were to estimate the benefit/cost ratio and the rate of return for investments in integrated pest management, to estimate the reduction in pesticide use due to adoption of integrated pest management, rather than traditional chemical-intensive approaches, and finally, to evaluate technology transfer for integrated pest management techniques.

The analysis included an examination of several agricultural commodities, including forestry. Impacts were projected into the future for each commodity. Arajii collected data on current and planned integrated pest management projects. Information was gathered on costs and benefits (both present and future) of each program as well as the expected benefits to be gained from the implementation of future technology research projects. Results varied greatly with commodities, and Arajii found that most benefits would not be realized without coordination of information dissemination and research implementation by the state Extension services. He also projects a reduction in most commodity prices and in total pesticide use with the adoption of integrated pest management practices.

FIRE MANAGEMENT - GUIDANCE FOR ECONOMIC ANALYSIS

Fire management is a program which is related to Forest Pest Management in that it involves protecting forest resources. Economic analysis of the Fire Management Program is in this sense relevant to the problem of analyzing the Forest Pest Management Program. I have included references to a few papers which appear to offer a direction for the development of a decision framework for values estimation for Forest Pest Management.

Gonzalez-Caban, Armando. The Economic Impact of Fire on Forest Resources: Improving the US Forest Service's Fire Management Planning System Capabilities to Use Non-Market Values. 1993. Wildfire, December 1993.

Due to the requirements of Multiple Use and Sustained Yield Act, the Rangeland and Renewable Resources Planning Act, and the National Forest Management Act, the Forest Service has made advances using economic values in planning, and non-market valuation of environmental amenities were incorporated in the 1985 and 1990 RPA Programs.

Nation Fire Management Analysis System (NFMAS) was developed in response to a demand from Congress that agencies use benefit/cost analysis as the basis for budget requests. This is a computer simulation to estimate efficiency of proposed programs (efficiency is measured by the expected marginal change in total program cost and net value change in resources that result from a change in budget). This paper discusses the need to incorporate non-market values into the NFMAS system, and the problems associated with non-market valuation and incorporating non-market values into fire planning.

The paper outlines a research approach to be accomplished in three phases: 1) obtain information from Forest Service fire managers to identify needs, 2) work with economists and decision analysts develop procedures to estimate fire effects and economic values and 3) incorporate these values info into Forest Service fire management planning.

An assessment of information needs finds these deficiencies: the kinds of non-market outputs and how they are considered in planning, the criteria used to describe, quantify and prioritize non-market outputs and the elements or factors necessary to measure or place value on non-market outputs for NFMAS. This paper points out the need to be responsive to the publics growing environmental values.

Baumgartner, D.C. and Simard, A.J. Wildland Fire Management Economics: A State of the Art Review and Bibliography. 1982. USDA Forest Service North Central Forest Experiment Station. General Technical Report NC-72.

Althaus, I.A. and Mills, T.J. Resource Values in Analyzing Fire Management Programs for Economic Efficiency. 1982. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, General Technical Report PSW-57.

These are two more examples of the type of work being done in Fire Management within the Forest Service.

CONCLUSIONS

This assessment of the available guidance for forest managers indicates a lack of direction for assessing the economic values associated with non-market and non-timber outputs. Academic research on non-market and non-commodity values associated with public lands and natural areas, as well as environmental amenities has been progressing for decades. For a complete review of work in resource economics related to forest pest management see Rosenberger, R.S., Economic Nonmarket Impacts of Forest Pests: A Review of the Literature (1995, Report to the USDA Forest Service, Forest Pest Management, Methods Application Group, in press). This report reviews work which seeks to quantify these values as they relate to forest protection. Most of these studies have been conducted with policy formulation or method development as an overall goal, rather than direct guidance for land managers.

Given that the science of resource and environmental economics had advanced to where more acceptable measures and techniques are being developed, it would seem reasonable that these sorts of values should be incorporated into guidance for land managers and planners. Another factor to consider is the growing level of awareness and concern for environmental values among the public. This set of values extends well beyond the traditional timber and commodity values and should be an integral part of forest pest management decisions.